Ontario

Computer Engineering Technician Program Standard

The approved program standard for all Computer Engineering Technician programs of instruction leading to an Ontario College Diploma delivered by Ontario Colleges of Applied Arts and Technology (MTCU funding code 50509)

Ministry of Training, Colleges and Universities
February 2006

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Inquiries regarding specific Computer Engineering Technician programs offered by colleges of applied arts and technology in Ontario should be directed to the relevant college.

This version replaces the program standard released in August 1998. Inquiries regarding this program standard should be directed to the address noted above.

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I. Introduction

This document is the Program Standard for all Computer Engineering Technician programs of instruction leading to an Ontario College Diploma delivered by Ontario colleges of applied arts and technology (MTCU funding code 50509). This version replaces the one released in August 1998.

Development of System-Wide Program Standards

In 1993, the Government of Ontario initiated program standards development with the objectives of bringing a greater degree of consistency to college programming offered across the province, broadening the focus of college programs to ensure graduates have the skills to be flexible and to continue to learn and adapt, and providing public accountability for the quality and relevance of college programs.

The Colleges Branch of the Ministry of Training, Colleges and Universities has responsibility for the development, review, and approval of system-wide standards for programs of instruction at Ontario colleges of applied arts and technology.

Program Standards

Program standards apply to all similar programs of instruction offered by colleges across the province. Each program standard for a postsecondary program includes the following elements:

- **Vocational standard** (the vocationally specific learning outcomes which apply to the program of instruction in question),
- **Essential employability skills** (the essential employability skills learning outcomes which apply to all programs of instruction), and
- **General education requirement** (the requirement for general education in postsecondary programs of instruction).

Collectively, these elements outline the essential skills and knowledge that a student must reliably demonstrate in order to graduate from the program.

Individual colleges of applied arts and technology offering the program of instruction determine the specific program structure, delivery methods, and other curriculum matters to be used in assisting students to achieve the outcomes articulated in the standard. Individual colleges also determine whether additional local learning outcomes will be required to reflect specific local needs and/or interests.

The Expression of Program Standards as Learning Outcomes

Learning outcomes represent culminating demonstrations of learning and achievement. They are not simply a listing of discrete skills, nor broad statements of knowledge and comprehension. In addition, learning outcomes are interrelated and cannot be viewed in isolation of one another. As such, they should be viewed as a comprehensive whole. They describe performances that demonstrate that significant integrated learning by graduates of the program has been achieved and verified.

Expressing standards as learning outcomes ensures consistency in the outcomes for program graduates, while leaving to the discretion of individual colleges curriculum matters such as the specific program structure and delivery methods.

The Presentation of the Learning Outcomes

The **learning outcome** statement sets out the culminating demonstration of learning and achievement that the student must reliably demonstrate before graduation.

The **elements of the performance** for each outcome define and clarify the level and quality of performance necessary to meet the requirements of the learning outcome. However, it is the performance of the learning outcome itself on which students are evaluated. The elements are indicators of the means by which the student may proceed to satisfactory performance of the learning outcome. The elements do not stand alone but rather in reference to the learning outcome of which they form a part.

The Development of a Program Standard

In establishing the standards development initiative, the Government determined that all postsecondary programs of instruction should include vocational skills coupled with a broader set of essential skills. This combination is considered critical to ensuring that college graduates have the skills required to be successful both upon graduation from the college program and throughout their working and personal lives.

A program standard is developed through a broad consultation process involving a range of stakeholders with a direct interest in the program area, including employers, professional associations, universities, secondary schools, and program graduates working in the field, in addition to students, faculty, and administrators at the colleges themselves. It represents a consensus of participating stakeholders on the essential learning that all program graduates should have achieved.

Updating the Program Standard

The Ministry of Training, Colleges and Universities will undertake regular reviews of the vocational learning outcomes for this program to ensure that the Computer Engineering Technician Program Standard remains appropriate and relevant to the needs of students and employers across the Province of Ontario. To confirm that this document is the most up-to-date release, contact the Ministry of Training, Colleges and Universities at the address or telephone number noted on the inside cover page.

II. Vocational Standard

All graduates of Computer Engineering Technician programs of instruction must have achieved the 9 vocational learning outcomes listed in the following pages, in addition to achieving the essential employability skills learning outcomes and meeting the general education requirement.

Preamble

Increasingly, individuals and organizations look to computers, be they stand-alone or networked, to optimize workflow, establish a presence in global markets, and improve communication. This pervasive integration of computers and their associated technologies has led to an emergence of job opportunities in the creation, integration, and support of technology systems and infrastructures.

Ontario colleges of applied arts and technology offer a wide variety of computer-related programs that prepare graduates for both existing and emerging opportunities in our society. At the heart of the computer technology education provided to Ontario college students is the ability to think critically, solve problems, and acquire new skills quickly. While these abilities are practised and enhanced in the context of a particular expertise, they are also transportable, with a reasonable training period, to other areas of expertise involving computers and their associated technologies.

Graduates of Computer Engineering Technician programs have acquired the knowledge and practical experience to support the continued extension of the application and ubiquitous nature of computing technology into our daily lives. As such, graduates are able to work individually or as part of a team to analyze, implement, and maintain software applications and hardware devices that make up computing devices and computer systems. From troubleshooting existing components to installing new ones, graduates work in a broad range of employment settings within the High Technology sector in both large and small organizations, as well as in any business that relies on the advantages of computer systems.

While the vocational learning outcomes for programs, such as Computer Engineering Technician, articulate the depth and breadth of skills, knowledge, and attitudes required by graduates when entering the work force, individual college programs may choose to build on this standard by offering some degree of specialization. Irrespective of the specialization, graduates' learning is significantly enhanced by opportunities for as much practical experience as is feasible during their time in the program.

There are many opportunities for graduates to pursue further educational qualifications; graduates may be granted credits towards a degree or certification through articulation agreements between the colleges and universities. Students should contact individual colleges for further details of a college's articulation agreements.

To be successful in a computer technology environment requires an ongoing commitment from the graduate to continue to update his/her skills to stay current in this rapidly changing field. Making use of knowledge and experience gained during their studies, graduates may also choose to apply for professional designations from provincial, national, and international organizations as a further demonstration of their commitment to keep their skills current.

Synopsis of the Vocational Learning Outcomes
Computer Engineering Technician Programs

The graduate has reliably demonstrated the ability to

1. **use documented solutions to troubleshoot technical problems involving computing devices.**

2. **support the integration of multiple software and hardware components using appropriate network architecture.**

3. **configure, troubleshoot, and maintain a variety of computer systems in accordance with documented functional requirements.**

4. **install and maintain the operations of a variety of computer hardware, software, and networked systems.**

5. **apply principles of digital and analog circuits to the troubleshooting of embedded computing devices.**

6. **contribute to the analysis, building, testing, implementation, and maintenance of applications.**

7. **apply knowledge of security issues related to computing devices.**

8. **conform to workplace expectations found in technology environments.**

9. **contribute to the successful completion of the project applying the project management principles in use.**

Note: The learning outcomes have been numbered as a point of reference; numbering does not imply prioritization, sequencing, nor weighting of significance.

The Vocational Learning Outcomes

1. *The graduate has reliably demonstrated the ability to*

   use documented solutions to troubleshoot technical problems involving computing devices.

Elements of the Performance

- Seek out appropriate troubleshooting procedures for problems of software installation, hardware installation, and networking components
- Acquire and use relevant technical information from a variety of sources (e.g., FAQs, knowledge bases, online support, vendor help desks)
- Classify technical problems involving computing devices
- Follow appropriate methodologies to resolve problems effectively and minimize risk of recurrence
- Contribute to the monitoring, reviewing, and assessment of the effectiveness of the troubleshooting procedure
- Recognize personal limits and seek assistance in a timely manner to resolve problems beyond own knowledge and skills
- Follow preventive maintenance schedules

2. *The graduate has reliably demonstrated the ability to*

support the integration of multiple software and hardware components using appropriate network architecture.

Elements of the Performance

- Apply basic principles of software and hardware integration (e.g., bar code scanners, radio frequency identification scanners, debit card readers, biometric security solutions)
- Apply basic principles of a variety of control systems and processes as required (e.g., robotics, point of sale systems, process control, sequential control)
- Support the integration of the TCP/IP stack for communication with remote devices and applications
- Support the development of solutions based on network technologies
- Apply knowledge of device connectivity, networks, and telecommunications
- Identify and assess appropriate mediums and topologies for a communications system
- Use a variety of strategies, tools, and techniques to integrate technologies
- Apply knowledge of industry standard protocols that relate to software and hardware
- Apply knowledge of security protocols and procedures
- Assess the merits of various operating systems and network architectures

3. *The graduate has reliably demonstrated the ability to*

configure, troubleshoot, and maintain a variety of computer systems in accordance with documented functional requirements.

Elements of the Performance

- Seek out relevant documented functional requirements
- Apply knowledge of the management and monitoring of networks to the maintenance of computer systems
- Use suitable computer components based on functional requirements
- Support the justification of the choice of computer architecture based on the functional requirements
- Follow documented configuration procedures
- Select and use standard tools, techniques, and equipment to troubleshoot and maintain computer systems

4. *The graduate has reliably demonstrated the ability to*

install and maintain the operations of a variety of computer hardware, software, and networked systems.

Elements of the Performance

- Select and use the proper tools, techniques, and equipment required to resolve operational and technical problems.
- Apply knowledge of the interrelationships between computer systems and application software to resolve operational and technical problems
- Apply appropriate principles and concepts of mathematics to analyze and resolve technical problems related to computer engineering environments
- Apply knowledge of network architecture and protocols to analyze and troubleshoot local-area networks
- Apply knowledge of electrical and timing compatibility
- Apply knowledge of power supplies
- Ensure installed components, both hardware and software, function as required
- Maintain software applications that are installed in both stand-alone and networked environments

5. *The graduate has reliably demonstrated the ability to*

apply principles of digital and analog circuits to the troubleshooting of embedded computing devices.

Elements of the Performance

- Apply knowledge of digital circuit design to the troubleshooting of embedded computing devices
- Apply knowledge of analog circuit design to the troubleshooting of embedded computing devices
- Read circuit diagrams of embedded computing devices
- Test and verify the electrical systems of embedded computing devices
- Troubleshoot the conversion of analog signals to digital signals and vice-versa
- Document and summarise results and procedures

6. *The graduate has reliably demonstrated the ability to*

contribute to the analysis, building, testing, implementation, and maintenance of applications.

Elements of the Performance

- Apply knowledge of a variety of user interfaces
- Apply knowledge of a variety of programming languages in order to perform routine tasks
- Apply basic knowledge of programming techniques (e.g., real-time, object-oriented)
- Apply basic knowledge of testing strategies, techniques, and tools
- Apply basic knowledge of debugging tools and techniques
- Apply basic knowledge of a variety of data structures
- Apply knowledge of assembly language as it relates to computer architecture
- Apply knowledge of a variety of mathematical principles and concepts to scale applications
- Prepare, present, and maintain current, clear, and accurate documentation
- Consider security requirements when using a software development methodology

7. *The graduate has reliably demonstrated the ability to*

apply knowledge of security issues related to computing devices.

Elements of the Performance

- Recognize malicious software that affects the reliability of computing devices
- Recognize security risks in firmware, software, and hardware implementation
- Recognizè the role of communication ports in the protection of computing devices
- Recognize the role of physical security in the protection of computing devices
- Research and use emerging secure communications protocols in the implementation of computing devices
- Apply knowledge of existing confidentiality and privacy regulations

8. *The graduate has reliably demonstrated the ability to*

conform to workplace expectations found in technology environments.

Elements of the Performance

- Recognize personal limits and seek assistance in a timely manner to resolve problems beyond own knowledge and skills
- Use language and terminology suited to the context
- Use electronic communication methods appropriately
- Keep abreast of relevant technological change
- Adhere to ethical principles and standards
- Follow organizational policies and procedures
- Identify guidelines set by appropriate organizations and bodies that prescribe quality programs, practices, processes, and procedures which apply to information technology environments (e.g., ISO, IEEE, CTAB)
- Ensure quality of assigned work
- Comply with software licensing requirements
- Keep abreast of existing confidentiality, privacy, and reporting regulations as they apply to daily work

9. *The graduate has reliably demonstrated the ability to*

contribute to the successful completion of the project applying the project management principles in use.

Elements of the Performance

- Participate in the planning, identification, scheduling, and assigning of tasks and resources involved in a project as required
- Contribute to the monitoring of resources and expenditures to maintain cost effectiveness and timelines as required
- Consolidate project updates regularly
- Estimate accurately the time required to complete project elements
- Complete project elements according to schedule
- Interpret and use project planning documents (e.g., Gantt Charts, Critical Path Analysis Charts, PERT Charts)
- Identify problems that will affect the project timeline and recommend changes as soon as possible
- Maintain current, clear, and accurate project-related documents which adhere to organizational and industry standards and procedures
- Use project management software

III. Essential Employability Skills

All graduates of Computer Engineering Technician programs of instruction must have reliably demonstrated the essential employability skills learning outcomes listed on the following pages, in addition to achieving the vocational learning outcomes and meeting the general education requirement.

Context

Essential Employability Skills (EES) are skills that, regardless of a student's program or discipline, are critical for success in the workplace, in day-to-day living, and for lifelong learning.

The teaching and attainment of these EES for students in, and graduates from, Ontario's colleges of applied arts and technology are anchored in a set of three fundamental assumptions:

- These skills are important for every adult to function successfully in society today.
- Our colleges are well equipped and well positioned to prepare graduates with these skills.
- These skills are equally valuable for all graduates, regardless of the level of their credential, whether they pursue a career path, or they pursue further education.

Skill Categories

To capture these skills, the following six categories define the essential areas where graduates must demonstrate skills and knowledge.

- Communication
- Numeracy
- Critical Thinking & Problem Solving
- Information Management
- Interpersonal
- Personal

Application / Implementation

In each of the six skill categories, there are a number of defining skills, or sub skills, identified to further articulate the requisite skills identified in the main skill categories. The following chart illustrates the relationship between the skill categories, the defining skills within the categories, and learning outcomes to be achieved by graduates from all postsecondary programs of instruction that lead to an Ontario College credential.

EES may be embedded in General Education or vocational courses, or developed through discrete courses. However these skills are developed, all graduates with Ontario College credentials must be able to reliably demonstrate the essential skills required in each of the six categories.

SKILL CATEGORY	**DEFINING SKILLS: Skill areas to be demonstrated by graduates:**	**LEARNING OUTCOMES: The levels of achievement required by graduates. The graduate has reliably demonstrated the ability to:**
COMMUNICATION	• Reading • Writing • Speaking • Listening • Presenting • Visual literacy	1. *communicate clearly, concisely and correctly in the written, spoken, and visual form that fulfills the purpose and meets the needs of the audience.* 2. *respond to written, spoken, or visual messages in a manner that ensures effective communication.*
NUMERACY	• Understanding and applying mathematical concepts and reasoning • Analyzing and using numerical data • Conceptualizing	3. *execute mathematical operations accurately.*
CRITICAL THINKING & PROBLEM SOLVING	• Analysing • Synthesising • Evaluating • Decision making • Creative and innovative thinking	4. *apply a systematic approach to solve problems.* 5. *use a variety of thinking skills to anticipate and solve problems.*
INFORMATION MANAGEMENT	• Gathering and managing information • Selecting and using appropriate tools and technology for a task or a project • Computer literacy • Internet skills	6. *locate, select, organize, and document information using appropriate technology and information systems.* 7. *analyze, evaluate, and apply relevant information from a variety of sources.*

SKILL CATEGORY	DEFINING SKILLS: Skill areas to be demonstrated by graduates:	LEARNING OUTCOMES: The levels of achievement required by graduates. The graduate has reliably demonstrated the ability to:
INTERPERSONAL	• Team work • Relationship management • Conflict resolution • Leadership • Networking	8. *show respect for the diverse opinions, values, belief systems, and contributions of others.* 9. *interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals.*
PERSONAL	• Managing self • Managing change and being flexible and adaptable • Engaging in reflective practices • Demonstrating personal responsibility	10. *manage the use of time and other resources to complete projects.* 11. *take responsibility for one's own actions, decisions, and consequences.*

IV. General Education Requirement

All graduates of Computer Engineering Technician programs must have met the general education requirement described on the following pages, in addition to achieving the vocational and essential employability skills learning outcomes.

Requirement

The General Education Requirement for programs of instruction is stipulated in the Credentials Framework (Appendix A in the Minister's Binding Policy Directive *Framework for Programs of Instruction*).

While the inclusion of General Education is locally determined for programs of instruction leading to either a college certificate or an Ontario College Certificate, it is recommended that graduates of the Ontario College Certificate programs have been engaged in learning that incorporates some breadth beyond the vocational field of study.

In programs of instruction leading to either an Ontario College Diploma or an Ontario College Advanced Diploma, it is required that graduates have been engaged in learning that exposes them to at least one discipline outside their main field of study, and increases their awareness of the society and culture in which they live and work. This will typically be accomplished by students taking 3 to 5 courses (or the equivalent) designed discretely and separately from vocational learning opportunities.

This general education learning would normally be delivered using a combination of required and elective processes.

Purpose

The purpose of General Education in the Ontario college system is to contribute to the development of citizens who are conscious of the diversity, complexity, and richness of the human experience; who are able to establish meaning through this consciousness; and, who, as a result, are able to contribute thoughtfully, creatively, and positively to the society in which they live and work.

General Education strengthens student's essential employability skills, such as critical analysis, problem solving, and communication, in the context of an exploration of topics with broad-based personal and / or societal importance.

Themes

The themes listed below will be used to provide direction to colleges in the development and identification of courses that are designed to fulfil the General Education Requirement for programs of instructions.

Each theme provides a statement of Rationale and offers suggestions related to more specific topic areas that could be explored within each area. These suggestions are neither prescriptive nor exhaustive. They are included to provide guidance regarding the nature and scope of content that would be judged as meeting the intent and overall goals of General Education.

1. Arts in Society:

Rationale:
The capacity of a person to recognize and evaluate artistic and creative achievements is useful in many aspects of his/her life. Since artistic expression is a fundamentally human activity, which both reflects and anticipates developments in the larger culture, its study will enhance the student's cultural and self-awareness.

Content:
Courses in this area should provide students with an understanding of the importance of visual and creative arts in human affairs, of the artist's and writer's perceptions of the world and the means by which those perceptions are translated into the language of literature and artistic expression. They will also provide an appreciation of the aesthetic values used in examining works of art and possibly, a direct experience in expressing perceptions in an artistic medium.

2. Civic Life:

Rationale:
In order for individuals to live responsibly and to reach their potential as individuals and as citizens of society, they need to understand the patterns of human relationships that underlie the orderly interactions of a society's various structural units. Informed people will have knowledge of the meaning of civic life in relation to diverse communities at the local, national, and global level, and an awareness of international issues and the effects of these on Canada, and Canada's place in the international community.

Content:
Courses in this area should provide students with an understanding of the meaning of freedoms, rights, and participation in community and public life, in addition to a working knowledge of the structure and function of various levels of government (municipal, provincial, national) in Canada and/or in an international context. They may also provide an historical understanding of major political issues affecting relations between the various levels of government in Canada and their constituents.

3. Social and Cultural Understanding:

Rationale:
Knowledge of the patterns and precedents of the past provide the means for a person to gain an awareness of his or her place in contemporary culture and society. In addition to this awareness, students will acquire a sense of the main currents of their culture and that of other cultures over an extended period of time in order to link personal history to the broader study of culture.

Content:
Courses in this area are those that deal broadly with major social and cultural themes. These courses may also stress the nature and validity of historical evidence and the variety of historical interpretation of events. Courses will provide the students with a view and understanding of the impact of cultural, social, ethnic, or linguistic characteristics.

4. Personal Understanding:

Rationale:
Educated people are equipped for life-long understanding and development of themselves as integrated physiological and psychological entities. They are aware of the ideal need to be fully functioning persons: mentally, physically, emotionally, socially, spiritually, and vocationally.

Content:
Courses in this area will focus on understanding the individual: his or her evolution; situation; relationship with others; place in the environment and universe; achievements and problems; and his or her meaning and purpose. They will also allow students the opportunity to study institutionalized human social behaviour in a systematic way. Courses fulfilling this requirement may be oriented to the study of the individual within a variety of contexts.

5. Science and Technology:

Rationale:
Matter and energy are universal concepts in science, forming a basis for understanding the interactions that occur in living and non-living systems in our universe. Study in this area provides an understanding of the behaviour of matter that provides a foundation for further scientific study and the creation of broader understanding about natural phenomena.

Similarly, the various applications and developments in the area of technology have an increasing impact on all aspects of human endeavour and have numerous social, economic, and philosophical implications. For example, the operation of computers to process data at high speed has invoked an interaction between machines and the human mind that is unique in human history. This development and other technological developments have a powerful impact on how we deal with many of the complex questions in our society.

Content:
Courses in this area should stress scientific inquiry and deal with basic or fundamental questions of science rather than applied ones. They may be formulated from traditional basic courses in such areas of study as biology, chemistry, physics, astronomy, geology, or agriculture. As well, courses related to understanding the role and functions of computers (e.g., data management and information processing), and assorted computer-related technologies, should be offered in a non-applied manner to provide students with an opportunity to explore the impact of these concepts and practices on their lives.